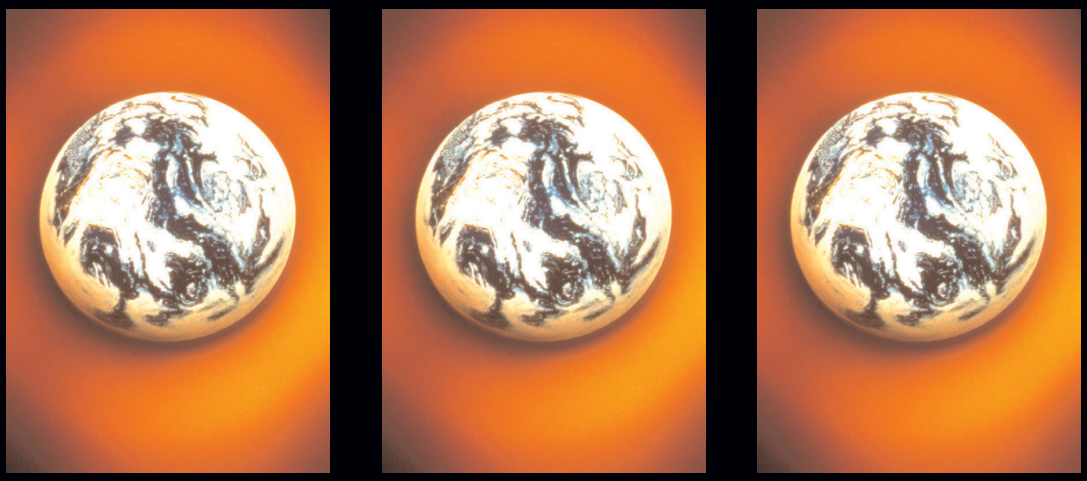
RENEWABLE ENERGY:



Empowering the Developing World

The total capacity of installed electrical power in the world is currently 3.4 million megawatts (MW). Of that, 1.5 million MW is in developing countries. About 30% of the global population—an estimated 2 billion people—currently lives without electricity. Most inhabit either remote rural areas of developing countries outside electrical power grids or urban areas with inadequate utility systems.

As these countries develop and grow, their need for energy will rise. The International Energy Agency predicts that developing countries will need to double their grid-based electrical power production by 2020—adding more than 1 million MW—to fuel continued economic growth. How will that mounting demand be met? For starters, applications such as energy for lighting, telecommunications, irrigation and other agricultural needs, cottage industries, heating water, and cooking are ideally suited to renewable energy.

"Governments and the development community are increasingly looking at renewable energy as the best way to supply distant communities with reliable power," says Eric Martinot, global climate change manager of the Global Environment Facility (GEF), a joint project of the World Bank, the United Nations Environment Programme, and the United Nations Development Programme. "Renewable energy can be used on its own or as a supplementary power source in developing countries," he says. "It can provide clean energy that protects the local environment and reduces greenhouse gas emissions [while reducing] dependence on foreign sources of energy."

The road to renewable energy in developing countries, however, is often blocked by obstacles, including high start-up costs, insufficient human and institutional infrastructure, relatively weak incentives, and inconsistent energy policies. Developing communities tend to rely on nonrenewable energy sources such as oil, gas, and firewood, as well as sources with high environmental impacts such as major hydroelectrical installations. But experts argue that developing countries could ultimately benefit by meeting their energy needs with renewable

Gaslight. A man in the Hebei Province of China turns on a methane-powered light.

Bill Wallace, DOE/NREL

photovoltaic power, small hydroelectrical technology, and biomass.

"Renewable energy technology is an advanced technology—whether it's high-tech or low-tech—which most developing countries are trying to use for everyday activities like cooking food, drying crops, and heating their homes," says Ali Sayigh, director general of the World Renewable Energy Network (WREN). "But a lot has to be done to transfer that technology to the communities that need it and to provide the advice needed to make it work."

Barriers to Progress

Until recently, the 87 homes on the tiny Chilean island of Tac had no electricity. But they did have a lot of wind, wind that blows over the Gulf of Ancud with significant force. As part of the Chilean government's efforts to electrify the entire country and to reach those communities outside of its electrical power grid, a pilot system that tapped into the island's wind power was installed on Tac. For the first time, the island's residents had refrigeration, television, and telephones, and the schools had electric lights. Soon after, a few stores opened up, and carpenters began using electric tools.

"Everybody on the island loves it," says Ian Baring-Gould, a senior mechanical engineer with the National Renewable Energy Laboratory (NREL) in Golden, Colorado. The NREL provided the data on wind resources that were critical to the design of Tac's power system. "The system uses a combination of wind and diesel to provide power to the whole island," he says. "The diesel is used to power the system at times when the wind power diminishes."

A principal barrier in this case was technological know-how—in order to build the right power system for that particular community, the designers needed to assess the precise natural resources; that is, they had to determine exactly how hard the wind blew and in what direction. Technology, however, is most often not a barrier to the use of renewable energy in developing countries. Power systems such as solar panels or wind turbines use a combination of simple and sophisticated equipment and can often be adapted to local conditions.

But not all renewable energy technologies are effective or desirable. In an attempt to reduce the overuse of firewood in some African communities, for example, solar cookers were introduced as an alternative method to cook food. The idea made sense at the time—develop a cooking technology that would take advantage of an abundance of sunlight. The problem, however, was that the solar cookers, often a simple box outfitted with small solar collectors, were too slow. Cooking the evening meal could take all day. Communities and families stopped using the cookers shortly after they were introduced.

According to Baring-Gould, most barriers are not technical but educational. "The challenge is convincing people at all levels in the community to adopt and accept the new technology, to understand how it fits and how it's used," he says. "You need everyone to work with everyone at all stages, from the regulators, who don't know how to develop a pricing structure for the equipment or the energy sold, to the technicians, who must repair systems and provide ongoing maintenance. This is quite an educational process for everyone involved."

Others barriers to the use of renewable energy can be political or broadly economic. A government may lack the will or means to address the needs of communities living beyond an existing energy framework. In recent years, however, some governments have begun to strengthen their efforts to bring clean and sustainable energy to areas in need of clean water and effective cooking facilities, as well as power for health centers, schools, and modern agricultural facilities.

The winds of change. A wind turbine in Chile supplies a village's energy needs.

Ian Baring-Gould, DOE/NREL

For example, while more than 98% of Thailand's rural areas have been electrified, approximately 750 villages are still too remote to access the state power grid. As in most developing countries, power in Thailand is provided by a state-run utility, which has recently developed a program to help bring low-cost stand-alone (therefore outside the grid) electricity sources to distant villages. The program is financed by taxes from the sale of fossil fuels within the country, and a portion of the monies will be spent on bringing wind, solar, and hydroelectrical power to the most rural areas.

Other barriers to renewable energy require more than a change in attitude, though, and can be far more difficult to overcome. Cost can be a huge factor—many residents and even whole communities can ill afford the up-front expense of many forms of renewable energy—which can vary from $400 to $800 per system, depending on the source and desired wattage—or the cost of long-term maintenance. These expenses can be prohibitive in most developing countries. For example, the average annual salary in Albania, one of the poorest countries in Europe, is about US$100 per year; the average annual salary for a city worker in China is just US$375. In recent years, the cost barrier has been tackled by the development of microcredit systems in which local banks make loans to the buyers of solar- or wind-powered equipment at reasonable rates. This system has seen some success in parts of Asia.

In Sri Lanka, for example, 4,000 solar home systems have been sold on credit since 1998, and that number is growing. "Sri Lanka is one of our success stories," says Martinot. "Many people needed a credit program to help them purchase a solar home system, and we've been working to set up mechanisms to provide them with access to credit. Fortunately, Sri Lanka already had a long history of microcredit—about one hundred years—and we found it relatively easy to find banks that would provide loans. But frankly, Sri Lanka is one of the very few examples of this microcredit mechanism working."

"The whole question of providing energy to a rural area is really one of cost," says Baring-Gould. "We always ask at the beginning, 'What's the cheapest way to get electricity to this area?' And it always depends on the community's priorities; for example, is it clean water, electricity in schools, cooking? In most cases, renewable

energy will be the cheapest solution. And we try to look at the tools, so to speak, that a community already has in its toolbox."

Overcoming Obstacles

One developing country is rapidly making the most of its toolbox. Although coal still dominates its energy needs, China is ahead of many other countries in its support of such renewable energy sources as solar power and biomass, particularly biogas, according to Debra Lew, senior project manager in the China Protocol Program at the NREL. "There is ample technology in China," she says. "The Chinese government has already done quite a lot and has been quite successful in disseminating various technologies throughout the country."

Over the past few decades, for example, millions of Chinese households have turned to biogas for their energy needs. The system is simple to use—the rural resident sets it up in a backyard and feeds into it animal or agricultural waste. The

A watched pot does boil. Contrary to the old adage, Chinese women watch as a solar cooker uses the sun's energy to heat water.

waste is converted to gas, which is then burned in an engine or generator for electricity. Although most rural areas in China are electrified, more than 6 million households still use biogas for residential lighting and other small energy needs.

China is also a leader among developing countries in the use of solar hot water heaters—of the 10 million in use in developing countries, most are in China, and the Chinese market tripled in the 1990s, according to Martinot. "The Chinese have a very concentrated government program with government-fostered industries," he says. With China still 90% rural, the potential for renewable energy sources that use locally available materials is still great.

Since the 1970s, Brazil has been aggressive in its attempts to use its own available materials for renewable energy sources. Its most ambitious program involves ethyl alcohol (ethanol) produced from biomass, primarily sugar waste. As a major producer of sugarcane, Brazil had an abundance of unused husks that could be burned to make ethanol. At the program's peak, Brazil was producing 200,000 barrels per day, replacing one-half of the gasoline that otherwise would have been used. The government even promoted a program 20 years ago to use ethanol fuel in automobiles in order to reduce the country's dependence on oil imports and reduce urban pollution. The trend in Brazil today is to use a blended fuel of ethanol and gasoline.

Some sugarcane producers have also developed programs in which they burn husks to generate electricity for their own operations or to sell to the local power companies. This program has helped support local manufacturers who often make the husk-burning equipment, providing jobs and helping to establish a strong agro-industrial system.

As a renewable resource, sugarcane is ideal for fulfilling at least some of the country's energy needs. The challenge, however, is fluctuating electricity rates—power producers using sugarcane must be guaranteed a certain price in order to make their enterprises profitable. If power prices fall too low, it becomes no longer profitable for the independent power producer to continue processing sugarcane husks into electricity, and the project will likely be abandoned. With power prices fixed, the producer can count on a stable income, and the project has a better chance of becoming sustainable.

In addition to helping meet a developing country's basic electricity needs, renewable energy sources are also finding their way into local industry and agriculture. For example, some sectors of the coffee industry have been gradually going solar. Although the price of coffee is currently low, thereby reducing the incentive to invest in new technologies, some growers in Panama have been attracted by the commercial potential of marketing their coffee as "solar-dried," and are planning to install "solar walls" to help dry the beans. A solar wall is a specialized wall made of standard metal siding that is perforated and installed on a south-facing wall in front of an intake air vent. The vent is equipped with a fan that draws naturally heated air into the wall and up the vent, and distributes it throughout the building's interior, where the freshly harvested beans are stored. In standard practice, the heat would be produced by diesel generators. The simplicity of the solar wall's design has made it particularly attractive in

A sweet idea. The husks of sugarcane are helping to fuel the industries—and thus, economy—of Brazil.

agricultural applications—a more complicated design might make it more prone to breaking down and needing repair. The solar wall is also used in other countries for other crops, including rice in Thailand, jujube (an edible fruit) in China, tobacco in Zimbabwe, and tea in India.

As Barriers Fall

As developing countries continue to industrialize and urbanize, their residential, community, and industrial energy needs will continue to increase. Because so many areas in developing countries still lack any substantial energy programs at all, the time is ripe to develop and implement projects that depend on renewable rather than nonrenewable energy sources from the start.

For this to happen, barriers must continue to drop as communities, governments, research institutions, private industry, and international agencies learn from these experiences and build on that growing knowledge. Developing countries can offer fertile ground for testing renewable energy technologies on a small scale. Someday, it's hoped, these technologies may be exported to the developed world to help meet rising energy needs there as well—a future of clean and healthy energy for all people depends on it.

Rebecca Clay

Left to right: Simon Tsuo, DOE/NREL; PhotoDisc